High Performance School Buildings

Resource and Strategy Guide

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The *High Performance School Buildings Resource & Strategy Guide* is a simple, easy-to-use roadmap for use in creating schools that:

- Provide better learning environments for students and teachers;
- Cost less to operate; and
- Help protect the environment.

Background
According to a recent General Accounting Office report, an estimated 6,000 new schools will be built nationwide by the year 2007. The sheer scope of this undertaking makes it clear that the U.S. is faced with a once-in-a-lifetime opportunity to shape the built environment in ways that will influence the lives of K-12 students for generations to come. High performance school buildings – those which incorporate the very best in today's design strategies and building technologies – can help make the most of this remarkable opportunity.

Designing and procuring energy- and resource-efficient schools is possible right now. All that's needed is the vision, determination, and knowledge to make high performance the *standard of performance* in school facility design and construction. This *Resource & Strategy Guide* provides the requisite knowledge, and is intended for those with the vision and determination to put this knowledge to work in building new schools.

"High performance facilities are a critical part of the equation for improving student outcomes in this country."

– Jack Lyons
Education Facilities Program Manager, U.S. Department of Education

Audience
The *Resource & Strategy Guide* has been developed specifically for those who control the process by which new schools are designed and built: school superintendents, business officials, board members, and other key decision-makers. It is not intended as the sole reference for architects and other design professionals, who have their own, more technical guidance for creating high performance buildings. It is structured to meet the needs of those who hire and manage the services of these professionals, and as a guide for further research by A/Es and others engaged in school facility design.

Organization
The *Guide* is organized into three core sections.

Section 1 provides an overview and two interrelated discussions:

- What is a High Performance School Building?
- Why is a High Performance School Building Valuable?

Schools currently spend more than $6 billion per year on energy, exceeding the combined cost of supplies and books. The U.S. Department of Energy estimates that energy costs, when combined with the costs of water, wastewater processing, and trash collection, average out at $125 per student per year. High performance buildings can reduce this number by up to $50 per student per year!

Section 2 is the *Process Guide,* which provides issue-specific questions that decision-makers can ask their design team as a means of driving the project toward the highest achievable levels of performance. The questions are organized according to the key phases of the development process:

- Programming and Goal Setting;
- Site Analysis;
- Selecting the A/E Team;
- Schematic Design;
- Design Development;
- Construction Documents;
- Bidding and Negotiation; and
- Construction Administration.

Section 3 contains the *Building Blocks* of High Performance School Buildings – 16 two-page 'briefs' that describe each of the key components which, when integrated as elements of 'whole building' design, result in a high performance building. Each brief describes:

- What the *Building Block* is;
- Why it's important to students and teachers, as well as to the school's bottom line;
- How it can be incorporated into the school's design;
- How it influences other building components and systems; and
- Where more detailed information can be found.

Taken together, the three sections provide a new and unique method for guiding the design and development process so that any new school – no matter what the budget – can achieve the highest performance levels possible for its particular circumstances.

What is a High Performance School Building?

Characteristics

A high performance school building has three key characteristics:

- It is **healthy and productive** for students and teachers, in that it provides…
  - High levels of acoustic, thermal, and visual comfort;
  - Large amounts of natural daylight;
  - Superior indoor air quality; and
  - A safe and secure environment.
- It is **cost effective** to operate and maintain, because its design employs…
  - Energy analysis tools that optimize energy performance;
  - A life cycle cost approach that reduces the total costs of ownership; and
  - A commissioning process that ensures the facility will operate in a manner consistent with design intent.
- It is **sustainable**, because it integrates…
  - Energy conservation and renewable energy strategies;
  - High performance mechanical and lighting systems;
  - Environmentally responsive site planning;
  - Environmentally preferable materials and products; and
  - Water-efficient design.

Creating a school with these characteristics is not difficult, but it does require an integrated, whole building approach to the design process. Key systems and technologies – the 'building blocks' of a high performance school – must be considered holistically, from the very beginning of the design process, and optimized throughout based on their *combined* impact on the comfort and productivity of students and teachers. At the conclusion of the process, the entire facility will be optimized to achieve long-term value and performance. The result will be a finished school that is an enduring asset to its community; one that enhances teaching and learning, reduces operating costs, and protects the environment.

Building Blocks

The following list summarizes the main Building Blocks of a high performance school – the components which, when integrated as elements of a 'whole building' design, will do the most to create a school that is healthy and productive, cost effective, and sustainable. Each of these topics is covered in detail under the *Building Blocks* section of the *Resource & Strategy Guide.*

- **Acoustic Comfort** – Students and teachers can hear one another without shouting. Noise from inside and outside the classroom is minimized.
- **Commissioning** – The school operates in accordance with design intent and meets the needs of the owner. This is made possible by implementing a formal commissioning process – a kind of 'systems check' for the facility. The process tests, verifies, and

Boscawen Elementary School
Boscawen, NH

This 420-student school is daylit and also utilizes 100% fresh outdoor air in a system that ensures superior air quality even as it saves energy.

"It's light, it's bright, and the use of space is so efficient for us, especially having come from a mid-1860s building. I've already sensed a calmness in the new building that is wonderful. It's an environment that's going to enhance our educational efforts. We expect to take off and do some remarkable things. The environment we're now living and working in will help us do that."

– Jane Lacasse, Principal

Roy Lee Walker Elementary School
McKinney, Texas
Independent School District

In one year, sufficient rainwater flows off the roof of this new K-5 school north of Dallas to meet the school's needs six times over. A portion of this water is captured and stored in cisterns – enough to water the grounds and flush the toilets year round.

Dena Boer Elementary School
Salida, CA

Skylights do double duty in this 800-student, K-5 school. They provide high quality light to the classrooms, while at the same time helping to vent air to the outside. In conjunction with operable windows, this allows for natural ventilation when the weather outside is temperate, thus saving on heating and cooling energy costs.

"The skylights create an open, bright work environment. We just seem to have more room. Visitors say it sure is a pleasant place to come into."

– Rick Bartkowski, Principal

fine-tunes the performance of key building systems so that they perform at the highest levels of efficiency.

- **Daylighting** – As much natural daylight as cost-effectively possible is provided, particularly in classrooms where it can do the most good. Daylighting systems are designed to avoid excessive heat loss or gain and to minimize glare.
- **Energy Analysis Tools** – The facility is designed to reduce short- and long-term energy costs as much as possible while maintaining a high quality learning environment. Energy analysis tools are used to predict the energy impacts of alternative design strategies and to select the best combinations of quality and energy efficiency.
- **Energy Efficient Building Shell** – The walls, floors, roofs, and windows of the school are as energy efficient as economically practicable. The building shell integrates and optimizes insulation levels, glazing, shading, thermal mass, air leakage, and light-colored exterior surfaces.
- **Environmentally Preferable Materials and Products** – To the maximum extent possible, the school incorporates materials and products that are durable, non-toxic, derived from sustainable-yield processes, high in recycled content, and easily recycled themselves.
- **Environmentally Responsive Site Planning** – To the extent possible, the school's site conserves existing natural areas and restores damaged ones, minimizes stormwater runoff and controls erosion, and enhances the building's high performance features.
- **High Performance HVAC** – The school's heating/ventilating/air conditioning (HVAC) system uses high efficiency equipment, is 'right sized' for the estimated demands of the facility, and includes controls that boost system performance.
- **High Performance Electric Lighting** – Students and teachers work in a high quality visual environment that stimulates learning while saving energy. The school's lighting system uses high efficiency lamps and ballasts, optimizes the number of light fixtures in each room, incorporates controls that ensure peak system performance, and successfully integrates electric lighting and daylighting strategies.
- **Life Cycle Cost Analysis** – The school is optimized with a view toward its total cost of ownership over time. Initial, operating, and maintenance/repair/replacement costs are compared for numerous design alternatives using a life cycle cost analysis tool or tools. The best combination of quality and long-term cost effectiveness is selected.
- **Renewable Energy** – The school maximizes the cost-effective use of renewable systems to meet its energy needs. During the design process, the following systems are systematically evaluated and considered: passive solar heating, solar hot water, active solar (for space heating), geothermal heat pumps, natural ventilation, wind-generated

electricity, photovoltaically generated electricity, and green power.

- **Safety and Security** – Students and teachers feel safe anywhere in the building or on the grounds. A secure environment is created primarily by *design*: opportunities for natural surveillance are optimized, a sense of territoriality is reinforced, and access is controlled. Security technology is used to enhance, rather than substitute for, the design features.
- **Superior Indoor Air Quality** – Students and teachers suffer no ill effects from the air inside the school. Sources of contamination are controlled, adequate ventilation is provided, and moisture accumulation is prevented.
- **Thermal Comfort** – Occupants are comfortable at all times. Temperature and humidity remain in the 'comfort zone.' Hot, stuffy rooms and cold, drafty ones are eliminated. Teachers have control over thermal conditions in individual classrooms.
- **Visual Comfort** – A rich visual environment is provided. The lighting for each room is 'designed', not simply specified. Daylight and electric light are integrated and optimized. Glare is eliminated.
- **Water Efficiency** – The school uses as little off-site water as possible to meet its needs. The school controls and reduces water run-off from its site, consumes fresh water as efficiently as possible, and recovers and reuses graywater to the extent feasible.